Impact of decentralization of investment decisions in power systems

Case Study 5 definition

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Which issue will be addressed ?

❑ Centralization vs decentralization of investments

- **Centralization** allows to exploit in a **common objective**
  - ➢ ***Geographical disparities*** in generation & consumption
  - ➢ ***Reduction of uncertainties*** by averaging
  - ➢ **Information** of the whole system
  - ➢ Lower **Cost of Capital**

- **Decentralization** allows to support
  - ➢ **Acceptance & active participation** of local actors
  - ➢ **Cross-sectoral coupling** (heat, biomass, mobility, …)
  - ➢ **Demand side management**

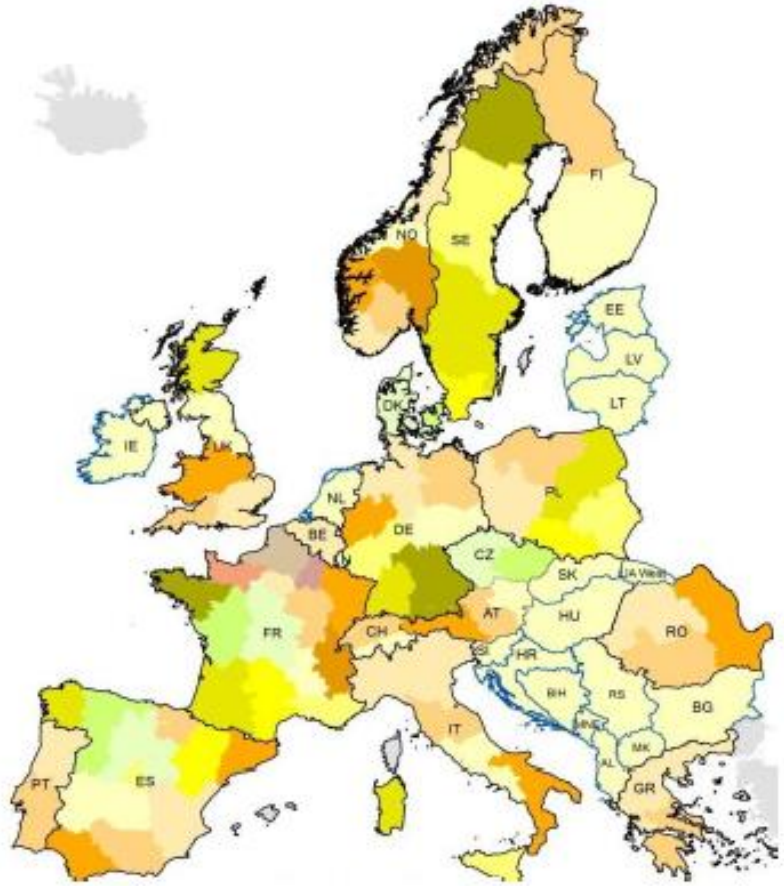
≠ ?

❑ Objectives

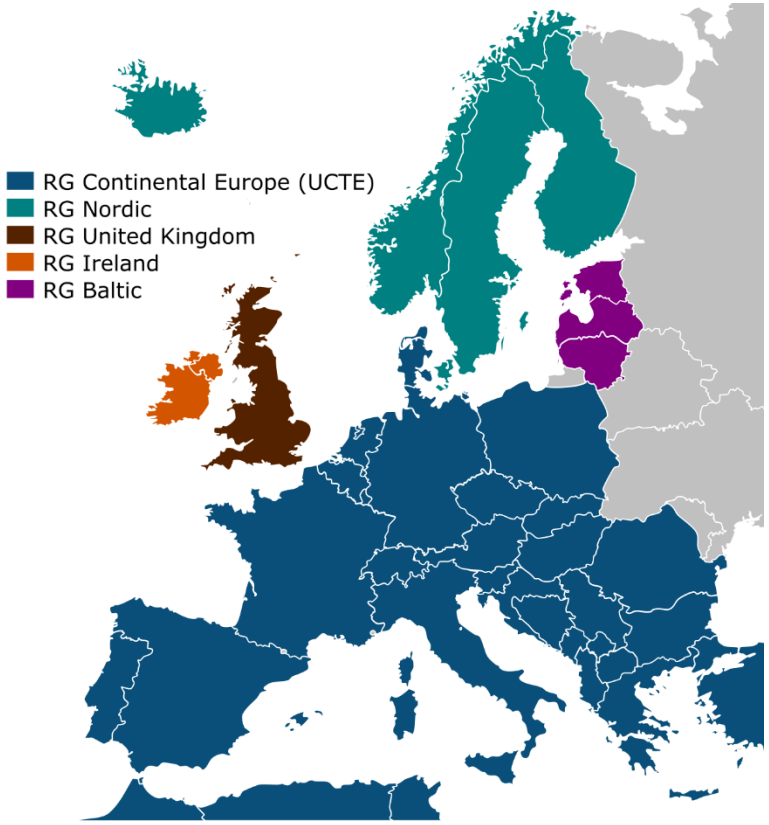
- **Assessing the impact of decentralization** of investment decisions on power systems
- **Giving insights** for relevant **coordination mechanisms**

Which geographical scales ? *Global vs Local*

Global: Europe
Local : Regions

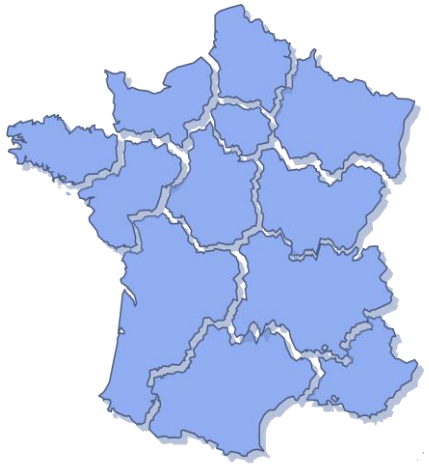


Global: Europe
Local : States



Global: State
Local : Regions

(first option)



From centralization to full decentralization…

❑ 3 variants

1. Centralization *(Optimization problem)*

- **Global cost function** = investment and operational costs
- **Global constraints** = supply/demand balance at each node of the grid
  ecological target for the whole system
  Ex: emissions limits or minimal renewable penetration

2. Decentralization of targets *(Optimization problem)*

- **Global cost function** = investment and operational costs
- **Local constraints** = supply/demand balance at each node of the grid
  specific ecological targets to each local entity

3. Full decentralization *(Game problem)*

- **Local cost functions** = investment and operational costs, CO2 emissions, …
- **Local constraints** = supply/demand balance, specific ecological targets, …
- **Assumptions on decisions/information/interactions** between local actors / central operator offering a backup

Which optimization tool ? Which Input / Output ?

Input ***from openENTRANCE Scenarios 2050***

- Transmission grid investment costs
- Costs and constraints of technologies
- Initial Installed capacities
- CO2 Budget
- CO2 and fuel prices
- Elec Demands per use (MWh)
- Ancillary services requirements
- Demand response potentials
- Renewables potentials
- Wind, PV, hydro Hourly profiles
- Demand hourly profiles
- Ancillary services requirements hourly profiles
- Demand-Response characteristics
- Distribution grid reinforcement costs
- Initial transmission and distribution Grid
- Exchanges at Boundaries

Plan4EU

Electricity sector

- **Capacity expansion** (generation and grid)
- **Seasonal Storage valuation** (stochastic)
- **Unit Commitment** (Monte-Carlo)

Output

- Quasi-optimal generation and grid mix
- Quasi-optimal investment and operational costs
- CO2 emissions
- Marginal costs
- Operation schedules (thermal, hydro, renewables curtailments, storage, demand response)
- Electricity not served
- Lower bound for optimal cost
- Hourly cost per technology

Plan4EU model

Investment

Capacity Expansion Model

- Stochastic investment planning
- Power system on **a single year operation (2050 horizon)**
- No pathway to reach the final electricity mix

Generation & grid
mix/capacities Scenario for the target year (2050)

Scenario Valuation

Seasonal Storage Valuation
(strategic decisions for large scale storages e.g. Hydro)

Water values

European Unit Commitment Model
(optimal dispatch with aggregated modelling of DC transmission grid)

Price signals / Dispatch / Time series

centralized

- Thermal Power Plant
- Central Storage (e.g. hydro)
- Centralized Demand Response
- Variable Renewable Generation

Distributed

- E-Mobility
- Distributed Storage
- Distributed Load Management
- Distributed Generation

Expected results

❑ Indicators

- Investments and operation costs
- Quasi-optimal mix (generation, storage, grid)
- CO2 emissions
- renewable curtailment level
- Prices as dual variables related to supply/demand constraints or capacity limits of power lines

❑ Variability of those indicators !!!

- by simulating the operation decisions on several scenario of uncertainties

❑ Bring relevant recommendations for coordination

What do you think ?

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3 Polls questions

1. **Which geographical scale ?**
2. **Which targets (constraints) ?**
3. **Which indicators ?**